

# ‘pst-math’

A PSTricks package for enhancing mathematical operators in PSTricks  
ver. 0.2

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‘libre’ is the french word for ‘free’

04/07/14

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## 1 Trigonometry

‘pst-math’ introduces natural trigonometric postscript operators COS, SIN and TAN defined by

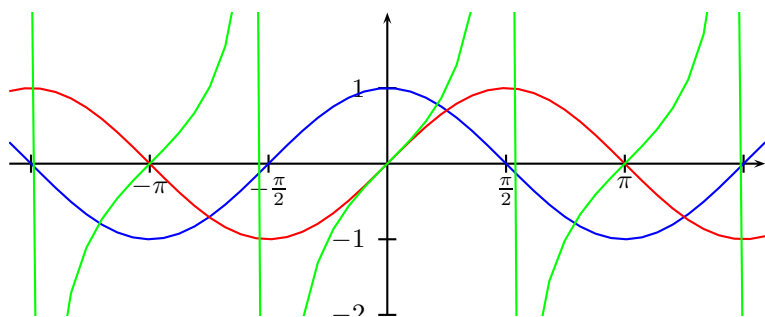
$$\cos : \begin{cases} \mathbb{R} & \rightarrow [-1, 1] \\ x & \mapsto \cos(x) \end{cases}$$

$$\sin : \begin{cases} \mathbb{R} & \rightarrow [-1, 1] \\ x & \mapsto \sin(x) \end{cases}$$

$$\tan : \begin{cases} \mathbb{R} \setminus \{k\frac{\pi}{2}, k \in \mathbb{Z}\} & \rightarrow \mathbb{R} \\ x & \mapsto \tan(x) \end{cases}$$

where  $x$  is in *radians*. TAN does *not* produce PS error<sup>1</sup> when  $x = k\frac{\pi}{2}$ .

Stack	Operator	Result	Description
<i>num</i>	<b>COS</b>	<i>real</i>	Return cosine of <i>num</i> radians
<i>num</i>	<b>SIN</b>	<i>real</i>	Return sine of <i>num</i> radians
<i>num</i>	<b>TAN</b>	<i>real</i>	Return tangent of <i>num</i> radians



```
\begin{pspicture}*(-5,-2)(5,2)
\SpecialCoor % For label positioning
\psaxes[labels=y,Dx=\pstPI2]{->}%
(0,0)(-5,-2)(5,2)
\uput[-90](!\PI 0){$\pi$}
\uput[-90](!\PI neg 0){$-\pi$}
\uput[-90](!\PI 2 div 0){$\frac{\pi}{2}$}
\uput[-90](!\PI 2 div neg 0){$-\frac{\pi}{2}$}
\psplot[linecolor=blue]{-5}{5}{x \COS}
\psplot[linecolor=red]{-5}{5}{x \SIN}
\psplot[linecolor=green]{-5}{5}{x \TAN}
\end{pspicture}
```

‘pst-math’ introduces natural trigonometric postscript operators ACOS, ASIN and ATAN defined by

$$\operatorname{acos} : \begin{cases} [-1, 1] & \rightarrow [0, \pi] \\ x & \mapsto \operatorname{acos}(x) \end{cases}$$

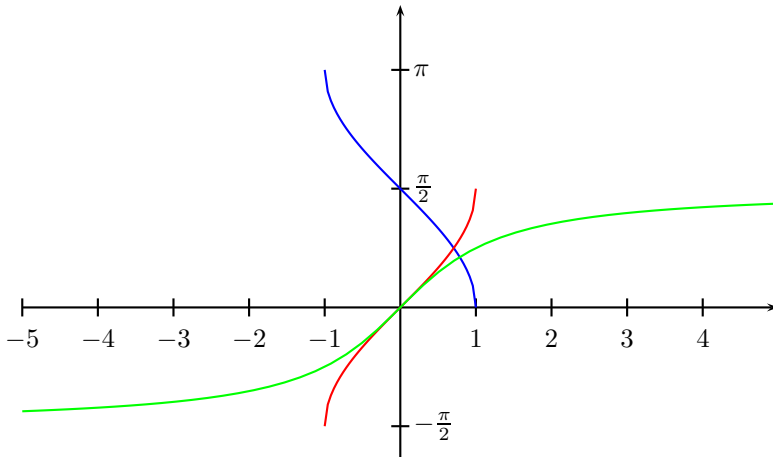
<sup>1</sup>TAN is defined with Div PSTricks operator rather than with div PS operator.

$$\text{asin} : \begin{cases} [-1, 1] & \rightarrow [-\frac{\pi}{2}, \frac{\pi}{2}] \\ x & \mapsto \text{asin}(x) \end{cases}$$

$$\text{atan} : \begin{cases} \mathbb{R} & \rightarrow ]-\frac{\pi}{2}, \frac{\pi}{2}[ \\ x & \mapsto \text{atan}(x) \end{cases}$$

Stack	Operator	Result	Description
<i>num</i>	<b>ACOS</b>	<i>angle</i>	Return arccosine of <i>num</i> in radians
<i>num</i>	<b>ASIN</b>	<i>angle</i>	Return arcsine of <i>num</i> in radians
<i>num</i>	<b>ATAN</b>	<i>angle</i>	Return arctangent of <i>num</i> in radians

**Important :** ATAN is *not* defined as PS operator atan. ATAN needs only *one* argument on the stack.



```
\begin{pspicture}(-5,-2)(5,4)
\SpecialCoor % For label positioning
\psaxes[labels=x,Dy=\pstPI2]{->}%
(0,0)(-5,-2)(5,4)
\uput[0](!0 \PI){$\pi$}
\uput[0](!0 \PI 2 div){$\frac{\pi}{2}$}
\uput[0](!0 \PI 2 div neg){$-\frac{\pi}{2}$}
\psplot[linecolor=blue]{-1}{1}%
{x \ACOS}
\psplot[linecolor=red]{-1}{1}%
{x \ASIN}
\psplot[linecolor=green]{-5}{5}%
{x \ATAN}
\end{pspicture}
```

## 2 Hyperbolic trigonometry

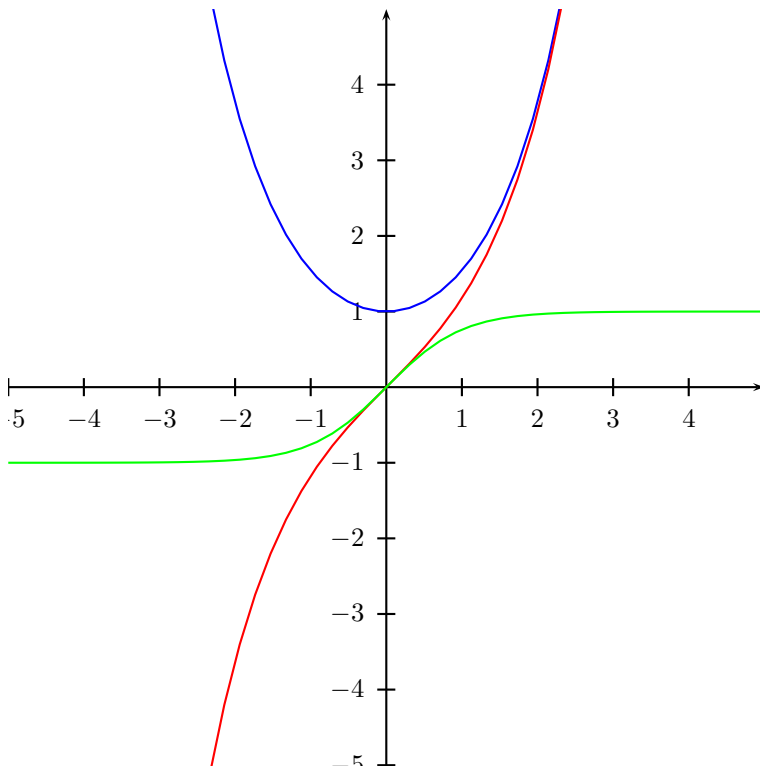
‘pst-math’ introduces hyperbolic trigonometric postscript operators COSH, SINH and TANH defined by

$$\cosh : \begin{cases} \mathbb{R} & \rightarrow [1, +\infty[ \\ x & \mapsto \cosh(x) \end{cases}$$

$$\sinh : \begin{cases} \mathbb{R} & \rightarrow \mathbb{R} \\ x & \mapsto \sinh(x) \end{cases}$$

$$\tanh : \begin{cases} \mathbb{R} & \rightarrow ]-1, 1[ \\ x & \mapsto \tanh(x) \end{cases}$$

Stack	Operator	Result	Description
<i>num</i>	<b>COSH</b>	<i>real</i>	Return hyperbolic cosine of <i>num</i>
<i>num</i>	<b>SINH</b>	<i>real</i>	Return hyperbolic sine of <i>num</i>
<i>num</i>	<b>TANH</b>	<i>real</i>	Return hyperbolic tangent of <i>num</i>



```
\begin{pspicture}*(-5,-5)(5,5)
\psaxes{->}(0,0)(-5,-5)(5,5)
\psplot[linecolor=blue]{-5}{5}{x \COSH}
\psplot[linecolor=red]{-5}{5}{x \SINH}
\psplot[linecolor=green]{-5}{5}{x \TANH}
\end{pspicture}
```

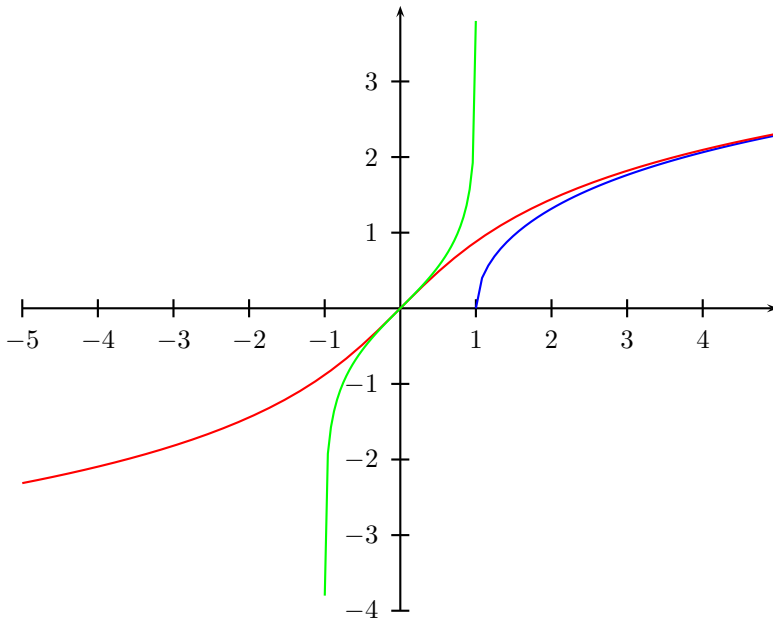
‘pst-math’ introduces reciprocal hyperbolic trigonometric postscript operators ACOSH, ASINH and ATANH defined by

$$\operatorname{acosh} : \begin{cases} [1, +\infty[ & \rightarrow \mathbb{R} \\ x & \mapsto \operatorname{acosh}(x) \end{cases}$$

$$\operatorname{asinh} : \begin{cases} \mathbb{R} & \rightarrow \mathbb{R} \\ x & \mapsto \operatorname{asinh}(x) \end{cases}$$

$$\operatorname{atanh} : \begin{cases} ]-1, 1[ & \rightarrow \mathbb{R} \\ x & \mapsto \operatorname{atanh}(x) \end{cases}$$

Stack	Operator	Result	Description
<i>num</i>	<b>ACOSH</b>	<i>real</i>	Return reciprocal hyperbolic cosine of <i>num</i>
<i>num</i>	<b>ASINH</b>	<i>real</i>	Return reciprocal hyperbolic sine of <i>num</i>
<i>num</i>	<b>ATANH</b>	<i>real</i>	Return reciprocal hyperbolic tangent of <i>num</i>



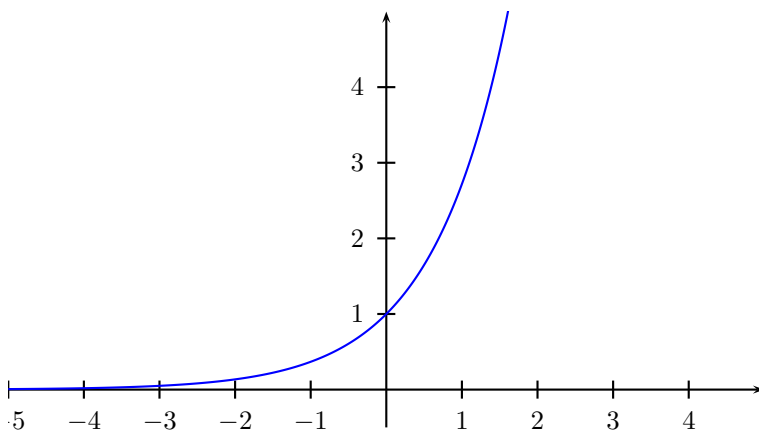
```
\begin{pspicture}(-5,-4)(5,4)
\psaxes{->}(0,0)(-5,-4)(5,4)
\psplot[linecolor=blue]{1}{5}%
{x ACOSH}
\psplot[linecolor=red]{-5}{5}%
{x ASINH}
\psplot[linecolor=green]{-.999}{.999}%
{x ATANH}
\end{pspicture}
```

### 3 Other operators

‘pst-math’ introduces postscript operator EXP defined by

$$\exp : \begin{cases} \mathbb{R} & \rightarrow & \mathbb{R} \\ x & \mapsto & \exp(x) \end{cases}$$

Stack	Operator	Result	Description
<i>num</i>	<b>EXP</b>	<i>real</i>	Return exponential of <i>num</i>

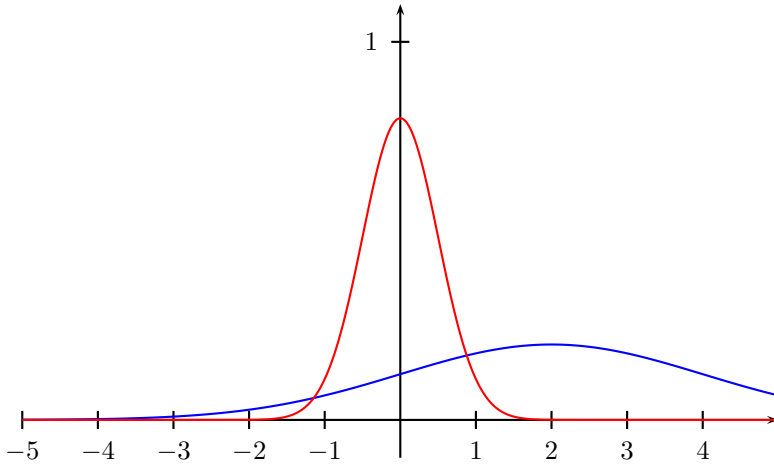


```
\begin{pspicture}*(-5,-1)(5,5)
\psaxes{->}(0,0)(-5,-0.5)(5,5)
\psplot[linecolor=blue,
plotpoints=1000]{-5}{5}{x EXP}
\end{pspicture}
```

‘pst-math’ introduces postscript operator GAUSS defined by

$$\text{gauss} : \begin{cases} \mathbb{R} & \rightarrow & \mathbb{R} \\ x & \mapsto & \frac{1}{\sqrt{2\pi\sigma^2}} \exp -\frac{(x - \bar{x})^2}{2\sigma^2} \end{cases}$$

Stack	Operator	Result	Description
<i>num</i> <sub>1</sub> <i>num</i> <sub>2</sub> <i>num</i> <sub>3</sub>	<b>GAUSS</b>	<i>real</i>	Return gaussian of <i>num</i> <sub>1</sub> with mean <i>num</i> <sub>2</sub> and standard deviation <i>num</i> <sub>3</sub>

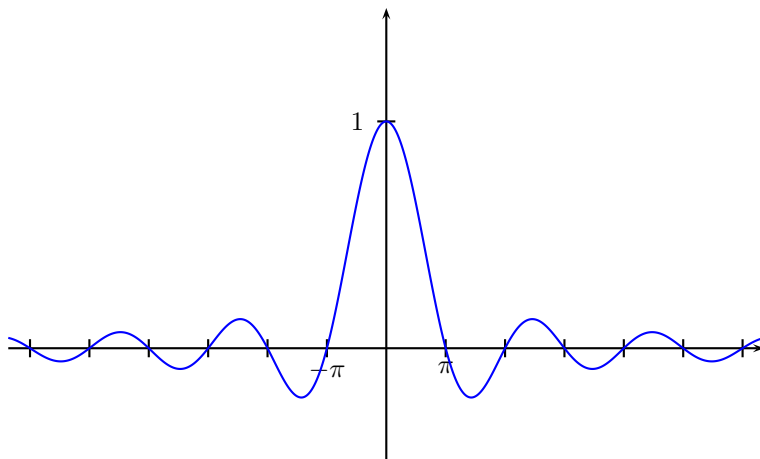


```
\psset{yunit=5}
\begin{pspicture}(-5,-.1)(5,1.1)
\psaxes{->}(0,0)(-5,-.1)(5,1.1)
\psplot[linecolor=blue,
  plotpoints=1000]%
  {-5}{5}{x 2 2 GAUSS}
\psplot[linecolor=red,
  plotpoints=1000]%
  {-5}{5}{x 0 .5 GAUSS}
\end{pspicture}
```

‘pst-math’ introduces postscript operator SINC defined by

$$\text{sinc} : \begin{cases} \mathbb{R} & \rightarrow \mathbb{R} \\ x & \mapsto \frac{\sin x}{x} \end{cases}$$

Stack	Operator	Result	Description
<i>num</i>	<b>SINC</b>	<i>real</i>	Return cardinal sine of <i>num</i> radians

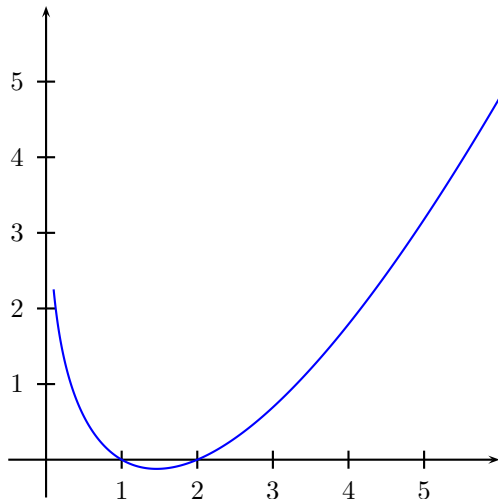


```
\psset{xunit=.25,yunit=3}
\begin{pspicture}(-20,-.5)(20,1.5)
\SpecialCoor % For label positionning
\psaxes[labels=y,Dx=\pstPI1]{->}%
  (0,0)(-20,-.5)(20,1.5)
\uput[-90](!\bPI 0){$\pi$}
\uput[-90](!\bPI neg 0){$-\pi$}
\psplot[linecolor=blue,
  plotpoints=1000]{-20}{20}{x SINC}
\end{pspicture}
```

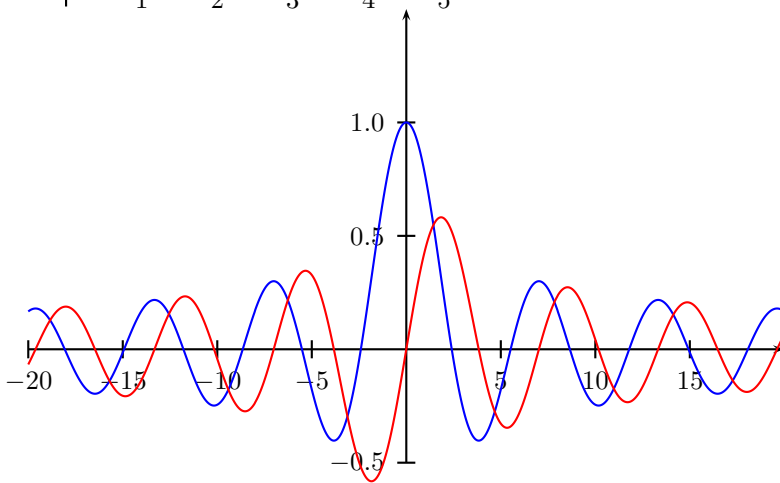
‘pst-math’ introduces postscript operator GAMMALN defined by

$$\ln \Gamma : \begin{cases} ]0, +\infty[ & \rightarrow \mathbb{R} \\ x & \mapsto \ln \int_0^t t^{x-1} e^{-t} dt \end{cases}$$

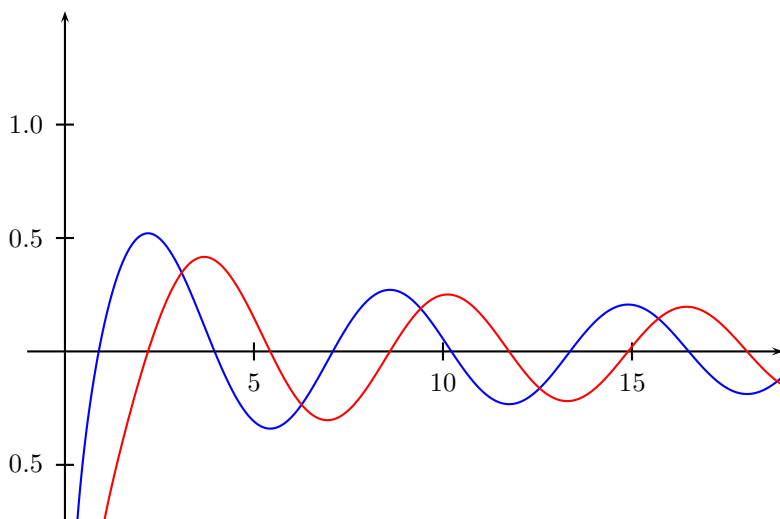
Stack	Operator	Result	Description
<i>num</i>	<b>GAMMALN</b>	<i>real</i>	Return logarithm of $\Gamma$ function of <i>num</i>



```
\begin{pspicture}(-.5,-.5)(6,6)
\psaxes{->}(0,0)(-.5,-.5)(6,6)
\psplot[linecolor=blue,
plotpoints=1000]{.1}{6}{x GAMMALN}
\end{pspicture}
```



```
\psset{xunit=.25,yunit=3}
\begin{pspicture}(-20,-.5)(20,1.5)
\psaxes[Dx=5,Dy=.5]{->}%
(0,0)(-20,-.5)(20,1.5)
\psplot[linecolor=blue,
plotpoints=1000]{-20}{20}%
{x BESSEL_J0}
\psplot[linecolor=red,
plotpoints=1000]{-20}{20}%
{x BESSEL_J1}
\end{pspicture}
```



```
\psset{xunit=.5,yunit=3}
\begin{pspicture}*(-1.5,-.75)(19,1.5)
\psaxes[Dx=5,Dy=.5]{->}%
(0,0)(-1,-.75)(19,1.5)
\psplot[linecolor=blue,
plotpoints=1000]{0.0001}{20}%
{x BESSEL_Y0}
\psplot[linecolor=red,
plotpoints=1000]{0.0001}{20}%
{x BESSEL_Y1}
% \psplot[linecolor=green,
% plotpoints=1000]{0.0001}{20}%
% {x 2 BESSEL_Yn}
\end{pspicture}
```

## 4 Infix-RPN and pst-infixplot support

You can now use the operators defined in 'pst-math' with the infix notation, using the infix-RPN package. The packages must be read in the following order:

$\LaTeX$  preamble

```
\usepackage{infix-RPN,pst-math}
```

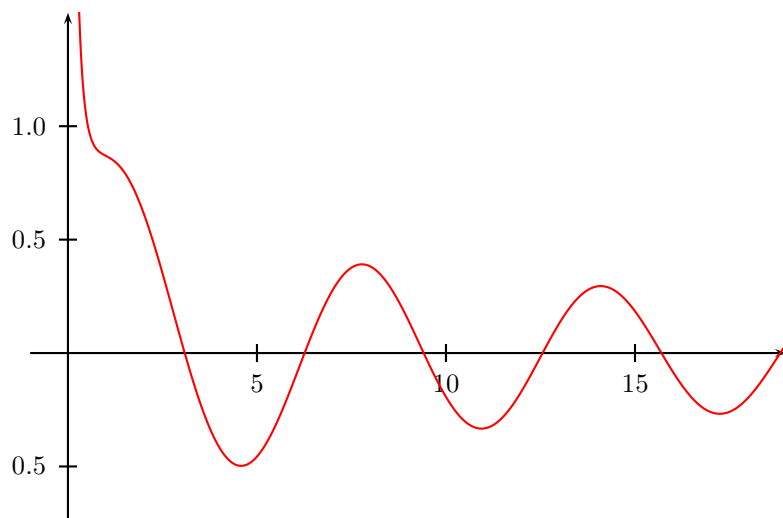
If you want to use 'pst-math' with pst-infixplot, then read the packages in the following order:

---

$\LaTeX$  preamble

---

```
\usepackage{pst-infixplot,pst-math}
```



```
\psset{xunit=.5,yunit=3}
\begin{pspicture}*(-1.5,-.75)(19,1.5)
\psaxes[Dx=5,Dy=.5]{->}%
(0,0)(-1,-.75)(19,1.5)
\psPlot[linecolor=red,
plotpoints=1000]{0.0001}{20}%
{BESSEL_Y0(x)-BESSEL_Y1(x)}
\end{pspicture}
```

## 5 Credits

Many thanks to Jacques L'helgoualc'h and Herbert Voss.